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BRL

ARMOR OPERATIONS IN MISSION ORIENTED PROTECTIVE POSTURE LEVEL IV (MOPPIV)

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19. ABSTRACT (Continue on reverse if necessary and identify by block number)

As a result of the concern for troop degradation due to the wearing of chemical protective equipment, a series of field tests were conducted to measure the correction factors for tasks performed in mission oriented protective posture, level IV (all equipment worn and sealed). This particular series of test was performed to quantify the degradation of an armor platoon. The field environment for these tests was moderate temperatures (45°-65° F) with low humidity. The tasks included pre-and post-operations preparation of the tanks, overmatch travel to a primary defense position and firing at targets while traversing a tank range.

Data were analyzed using standard statistical procedures and a MOPPIV correction factor was defined as that value by which the time to complete a task in BDU should be multiplied while wearing MOPPIV. ~~These measured factors are:~~

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Task	Correction	
	Factor	Range
Prepare Driver Station	1.1	0.8-1.4
Check Engine and Transmission Fluid Levels	1.2	0.9-1.5
Preform PM and After Ops. Checks and Service	1.2	0.9-1.4
Platoon Movements	1.6	1.4-1.8
Target Acquisition	1.0	1.0
Firing Accuracy	1.0	0.9-1.0

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I. INTRODUCTION

1. Background

Troop performance degradation due to chemical protective equipment has been of increasing concern to military commanders. This protective equipment is worn in one of four configurations referred to as mission oriented protective posture (MOPP) levels. MOPPIV, which refers to wearing of the equipment at level IV during which all protective equipment is worn and sealed, is the most protective, bulky, cumbersome and restrictive mode. In this report, "MOPPIV" refers to wearing of the equipment at level IV and "MOPPIV time" to the amount of time required to complete a task while wearing the protective equipment. Personnel are protected at the expense of their encumbrance, a circumstance which results from impeded physiological functions such as vision, hearing, speaking, manual dexterity and others. This encumbrance produces degradation in the form of (usually) increased time to complete tasks and in some cases reduced accuracy. In order that these degradations might be quantified for use in simulations, war gaming and other studies of unit effectiveness and combat readiness, field studies are deemed necessary because laboratory exercises typically introduce artifacts that can bias results.

A portion of an extensive DoD sponsored and Dugway Proving Ground (DPG) administered program, referred to as DO-49, was implemented to satisfy the required need for field testing and to quantify the effect of wearing MOPPIV on personnel performing military tasks. The current program includes five specific operational areas scheduled for operations testing in cold, moderate and hot temperatures (Table 1).

TABLE 1. DO-49 MOPPIV Programs

Study Areas
Maintenance Operations
Armor Operations
Signal Operations
Missile Operations
Night Reconnaissance Operations

The Vulnerability/Lethality Division of the Ballistic Research Laboratory (BRL) has an extensive on-going program for assessing the vulnerability of military systems on the integrated

battlefield to include the effects of conventional, nuclear and chemical munitions on the effectiveness of various units. The model for this program is the Army Unit Resiliency Analysis (AURA) methodology.[1] This methodology utilizes inputs from all areas having impact on the ability of a unit to accomplish a mission, including the effect of wearing MOPPIV. Because degradation data for most military operations are not available and the need exists to include them in AURA, the BRL developed an algorithm[2] to estimate personnel degradation due to MOPPIV.

One major concern in interpreting field data is the need to establish a degradation value. It is not unusual to find subjective judgements made on the effect of protective equipment with no objective, data supported estimate of the effect or the variation recorded. One purpose of this effort is to provide a numerical estimate of the equipment effect and the associated variation.

This report presents the results of the second MOPPIV investigation; i.e., an Armor Operation study conducted in a hot environment with temperatures ranging between 70 and 90°F at Camp Pendleton, California from 23 October through 2 November 1984.

2. Objective

The primary objective of the Do-49 program was to evaluate the operational capabilities and quantify the degradation of a tank platoon in the active defense mode in MOPPIV. These measurements included the ability of the tank crew members to perform:

a. Military occupational specialty (MOS) related tasks

b. Tank platoon operations.

c. Acquire and engage targets.

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1. J.T. Klopcic and L.K. Roach, "An Introduction to the Use of the Army Unit Resiliency Analysis (AURA) Methodology: Volume I," US Army Ballistic Research Laboratory, Memorandum Report No. 3384, September 1984, (UNCLASSIFIED).

2. C.H.Wick, "Performance Estimates for Operations Conducted While Wearing Individual Protective Equipment: User Manual," BRL-MR-3647, 1988.

II. APPROACH

1. Overview

The measure of degradation for the tank trials was the time difference between performing the task in battle dress uniform (BDU) and MOPPIV. For these trials there were three tank platoons, each consisting of four tanks. Degradation measurements were made for platoon tasks, such as field movement, as well as individual crew member tasks, such as tank preoperation checks. A trained observer, whose goals were to time each individual task and to rate the tank performance in the overall platoon operation, was assigned to each tank. The platoon movement times were measured in real time and recorded by means of radio communication with the platoon commander.

The three tank platoons which participated in the trials were comprised of crew members who had been trained in the appropriate MOS and the tanks of each platoon had previously maneuvered together. The crew members had received the annual individual training in the MOPP equipment but had received no special training for these trials which might have influenced the outcome of the tests.

Since these tests were repetitive, individuals would gain experience as they progressed through the trials. In an effort to control and later estimate the experience effect, a certain trial uniform pattern was selected. The trial sequence was BDU followed by two MOPPIV trials for the first platoon tested, MOPPIV followed by a BDU and another MOPPIV for the second platoon and finally two MOPPIV trials followed by the BDU trial for the final platoon. For the purposes of this analysis, all references to "first time effect" pertain to the first iteration, first trial for each platoon.

Three items of data were available for analysis: first, the time to complete a task, both individual and platoon; second, the protective profile (BDU/MOPP); and third, whether it was the first trial or a subsequent one. During the performance of individual tasks (preoperation and postoperation), a video record was made of each tank and the individuals performing the tasks. During the platoon movements, the video overview record was made of the platoon travel.

A multiple linear regression technique[3] was used to estimate

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3. C.H.Wick and J.A.Morrissey, "Maintenance Operations in Mission Oriented Protective Posture Level IV," BRL-MR-3620, 1987.

the effect of the chemical protective equipment and the effect of practice on the total time to complete both individual and platoon tasks.

2. Trial Description

The trials were designed to exercise a tank platoon in the active defensive posture. It included platoon preoperation tasks, tank movement, establishing a primary defensive position (PDP), enemy engagement and reconsolidation at the alternate position (AP) and the performance of the postoperation tasks. Figure 1 is a schematic drawing of the trial travel routes and positions.

a. **Preoperation Tasks.** At the beginning of a trial, the platoon leader and his tank commanders gathered and were given the operations plan for the day by the test coordinators. After receiving the plan, they returned to their respective tanks and coordinated the day's operation with their crews. At this point in time the test participants were told whether to wear the MOPPIV equipment or remain in BDU.

After these initial preparations, the preoperation tasks listed in Table 2 were begun and the completion times for each recorded by the trained observer assigned to each tank.

Table 2. Preoperation Tasks

Task No.	Task Title
1.	Perform preventive maintenance (PM) and prepare to fire checks (Gunner)
2.	Prepare Loader station
3.	Prepare Driver station
4.	Boresight .50 cal machine gun (MG)
5.	Perform PM and Prepare to Fire Checks (TCom)
6.	Load M239
7.	Check engine and transmission fluid levels
8.	Boresight 105-mm gun
9.	Load COAX MG

b. **Platoon Movement.** After the preoperation tasks had been completed, the platoon movement to the PDP began. This platoon movement was to be performed as a traveling-over-watch (one tank advancing a short distance toward the objective while the other tanks in a concealed posture looked for the enemy). This movement was graded by the observer on each tank. Two phase

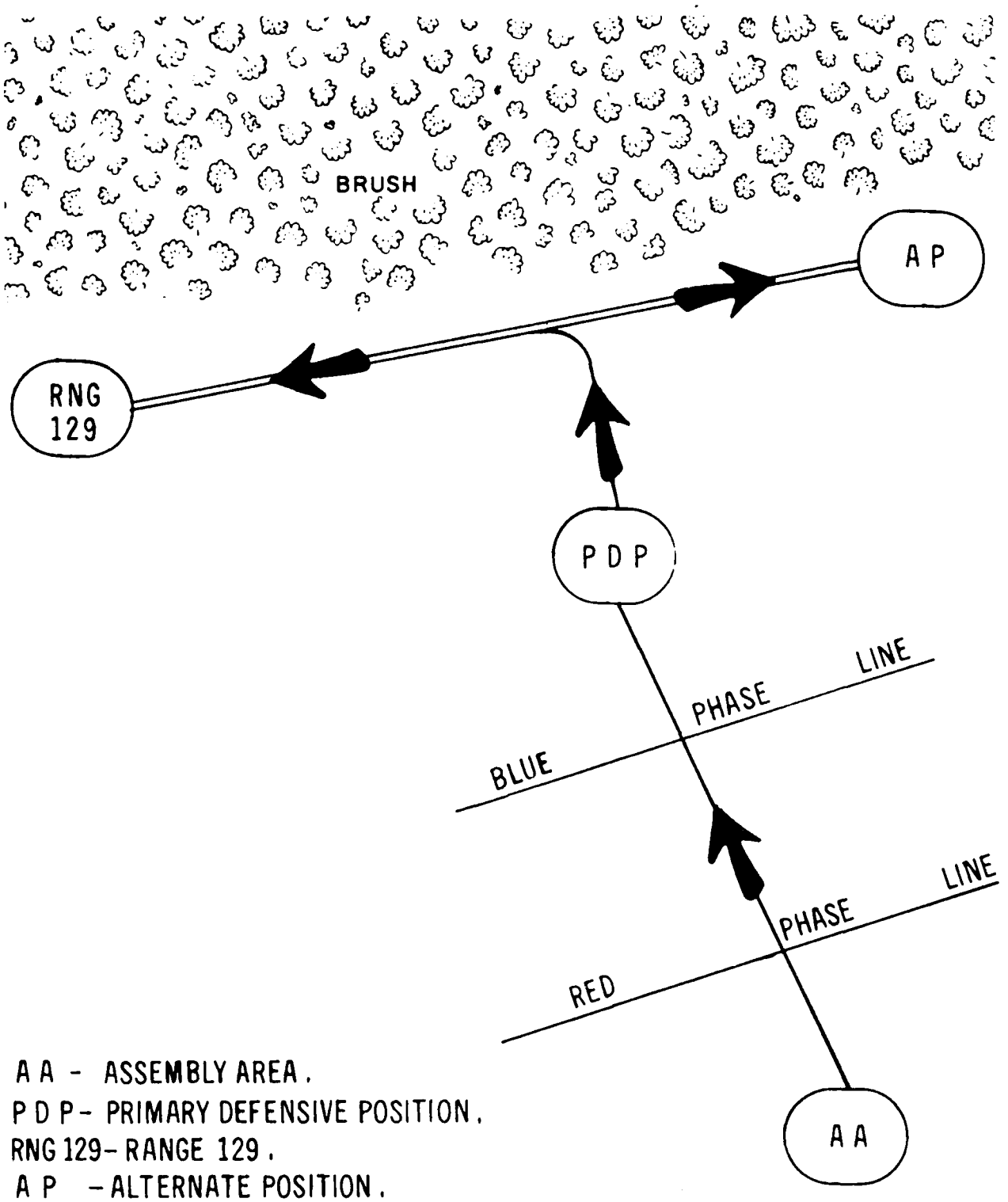

Figure 1. Travel Schematic Map

lines, which were previously selected by the test personnel and remained constant for all tests, were reported by the platoon commander as each was crossed and the time was recorded. As the tanks were traveling between the assembly area and the primary defense position, any video recording crews observed by the tank crews were reported to the test coordinators as friendly "news" teams. The number of observations was recorded but the data were not analyzed.

c. **Establishment of Primary Defense Position.** After arrival at the preselected PDP, the platoon commander and his tank commanders reconnoitered the area, established the best defensive position and established security for the area. After the platoon security force had been positioned, the test coordinators notify a waiting aggressive force and the platoon was attacked by a TOW squad and several infantry squads. During this attack by the aggressive forces, the tank commanders reported to the test coordinators the situation and their respective counter measures to the attack. These responses were recorded and at a later time, the tank commander was advised of any mistakes made or attacking forces not observed. The data were not analyzed for MOPP equipment effects.

d. **Enemy Engagement.** When the PDP portion of the trial had been completed, the platoon proceeded to the firing range for enemy target engagements. Because of the possible personnel hazard associated with operating the tank along a narrow dirt road which was under repair at two intersections, the driver and tank commander were allowed to open their respective hatches during this travel. The travel times were recorded. After arrival at the range, the platoon assembled behind a berm built at the edge of the firing range to conceal the range targets from tanks waiting to fire on the range. Each tank was required to travel the range alone and fire at all detected targets. The data recorded on the range included the time to engage a target, the time to fire the first round, the number of targets presented, the number of targets detected and engaged and the firing accuracy of each crew. If more than one target was presented as an engagement, the time to fire the first round at the second target, after a first target kill, was also recorded.

During the range travel, certain tanks released smoke and all tanks fired the machine gun. Neither task was rated nor timed.

e. **Reconsolidation.** After completion of the range firings, the tank platoon proceeded to the AP (with the driver and commander hatches open). These travel times were also recorded. At the AP each tank crew performed the required postoperation tasks and the completion times were recorded by the tank observer. A list of these postoperation tasks can be found in Table 3.

Table 3. Postoperation Tasks.

Task No.	Task Title
1.	Perform Operator Maintenance on the 50 cal MG
2.	Unload Stuck 105-mm Round
3.	Perform preventive maintenance (PM) and After Firing Checks (Gunner)
4.	Fill and Bleed Replenisher
5.	Perform PM and after operations checks and service
6.	Perform PM and after firing checks (Loader)
7.	Perform operator maintenance on M73 COAX MG
8.	Remove and install a Track Pad

3. Second Iteration

Each test day was scheduled to have two iterations approximately five to six hours long. However, because of the time of year (late October), there was not enough daylight to perform two complete iterations. Therefore, the second iteration, if performed at all, was normally with a shortened test procedure and after the platoon had received an hour rest during which the tank crews ate lunch and were allowed to remove the MOPP garments. This second iteration was intended to measure the added degradation created after being in MOPPIV for six hours but for this report the data were not analyzed from this perspective.

III. RESULTS

This section contains the time data collected for individual task and tank movements and a summary of the firing accuracy data recorded at the firing range. A complete listing of all the firing data can be found in Appendix A.

1. Individual Tasks Data

a. **Preoperational Tasks.** Tables 4, 5 and 6 contain the time data recorded for the preoperational tasks. Tasks 6 and 7 could not be performed at the assembly point because of safety restrictions; however, the responsible person did proceed through the motions of loading an M239 smoke grenade launcher and the COAX machine gun. Because there were no 105 mm rounds on board, the loader was also forced to proceed through the motions of preparing the loader station. These discrepancies should be considered when reviewing the data.

Table 4. Preoperational Task Times : Tasks 1, 2 and 3

		Time to Perform Task (sec)					
		BDU		MOPP		MOPP-L	
	Iteration	1	2	1	2	1	2
Preoperation Task 1: Perform PM and Prepare to Fire Checks (Gunner)							
Platoon	Crew No.						
First	1	253	145	190	405	423	439
Third	1	420	493	327	257	71	66
Fourth	1	90	40	150	0[a]	86	60
Preoperation Task 2: Prepare Loader Station							
Platoon	Crew No.						
First	1	243	30	102	170	270	92[b]
Third	1	130	493[b]	327	257	30	0
Fourth	1	50	0	88	0[a]	88	58
Preoperation Task 3: Prepare Driver Station							
Platoon	Crew No.						
First	1	189	50	121	120	243	112
	3	203	129	476	160	151[b]	110
Third	1	120	411	48	302	0	60
	3	195	83	25	37[a]	143	52
Fourth	1	60	30	82	0[a]	89	8080
	3	104	178	298	0[a]	238	258

a. Second iteration was not performed.

b. Data not recorded.

Table 5. Preoperational Task Times : Tasks 4, 5 and 6

		Time to Perform Task (sec)					
		BDU		MOPP		MOPP-L	
Iteration		1	2	1	2	1	2
Preoperation Task 4: Boresight 0.50 cal MG							
Platoon	Crew No.						
First	2	345	240	180	110	1290	1100
	3	1049	861	1652[b]	1190[b]	1337[b]	914[b]
Third	2	592	434	0[b]	0[b]	0[b]	0[b]
	3	978[b]	585[b]	659	654[a]	0[b]	876[b]
Fourth	2	0[b]	0[b]	795	0[a]	0[b]	0[b]
	3	853	906	1371	0[a]	1110	1109
Preoperation Task 5: Perform PM and Prepare to Fire Checks (TCom)							
Platoon	Crew No.						
First	2	195	200	170[b]	375	167	260
	4	179	187	0[b]	20[illegible]	210	229
Third	2	127	507	335	418	498	263
	4	164	**	420	214[a]	185	123
Fourth	2	220	100	330	0[a]	553	132
	4	268	190	413	0[a]	160	224
Preoperation Task 6: Load M239							
Platoon	Crew No.						
First	2	125	125	305	320	250	245
	4	120	93	139	120	48	160
Third	2	556	474[b]	215	418	89	162
	4	82	0[b]	157	108[a]	147	96
Fourth	2	300	215	1210	0[a]	716	228
	4	192	65	63	0[a]	212	174

a. Second iteration was not performed.

b. Data not recorded.

Table 6. Preoperational Task Times : Task 7, 8 and 9

		Time to Perform Task (sec)					
		BDU		MOPP		MOPP-L	
	Iteration	1	2	1	2	1	2
Preoperation Task 7: Check Engine and Transmission Fluid Levels							
Platoon	Crew No.						
First	2	62	195	195	120	132	165
	4	111	133	230	200	133	230
Third	2	303	725[b]	504	484	215	304
	4	280	0[b]	165	201[a]	175	282
Fourth	2	200	155	1005	0[a]	896	410
	4	65	120	156	0[a]	331	175
Preoperation Task 8: Boresight 105 mm Gun							
Platoon	Crew No.						
First	3	429	429	1416	702	475	276
Third	3	295	222	247	195[a]	285	181
Fourth	3	297	344	1104	0[a]	375	476
Preoperation Task 9: Load COAX MG							
Platoon	Crew No.						
First	3	78	0[b]	90	105	89	39
Third	3	26	34	35	97[a]	60	26
Fourth	3	38	26	36	0[a]	36	31

a. Second iteration was not performed.

b. Data not recorded.

b. **Postoperational Tasks.** Tables 7, 8 and 9 contain the time data for the postoperational tasks. Personnel performing task 2 were forced to go through the motions because of the nonavailability of 105 mm rounds. Task 8 was also simulated. For this task, the track was checked by a crew member. This checking included dismounting from the tank and checking the track tension with a crowbar. These discrepancies should be considered when the data are being studied.

2. Platoon Travel Times

The platoon travel times are shown in Table 10. The RED and BLUE phase line times are independent times and the total time to travel between the assembly point and the PDP is entered in the "Total" column. The travel times for the phase lines may differ between platoons because of the different travel and reporting techniques used by the individual platoon commanders. As was mentioned earlier, the travel to the range from the PDP and the return trip to AP was performed with the driver and commander hatches open for better visibility and safety.

Table 7. Postoperational Task Times : Tasks 1 and 2

		Time to Perform Task (sec)					
		BDU		MOPP		MOPP-L	
	Iteration	1	2	1	2	1	2
Postoperation Task 1: Perform Operator Maintenance on the 50 Cal MG							
Platoon	Crew No.						
First	1	0[b]	0[b]	390	94	256	135
	4	133	310[b]	180[b]	130[b]	238[b]	178[b]
Third	1	151	0[b]	0[b]	0[b]	0[b]	0[b]
	4	157[b]	0[b]	88	150[a]	114	64
Fourth	1	0[b]	0[b]	120	0[a]	82	70
	4	0[b]	184	119	0[a]	289	140
Postoperation Task 2: Unload Stuck 105-mm Round							
Platoon	Crew No.						
First	1	18	30	40	26	30	30
	4	94	90	70	90	47	83
	3	204	52[b]	140[b]	87	87[b]	38
Third	1	105	0[b]	0[b]	83	0[b]	35
	4	72	0[b]	48	42	38	38
	3	10[b]	0[b]	30[b]	54[a]	51	93
Fourth	1	0[b]	0[b]	0[b]	0[a]	60	56
	4	184	0[b]	90[b]	0[a]	194	130
	3	54	0[b]	0[b]	0[a]	78	58

a. Second iteration was not performed.

b. Data not recorded.

Table 8. Postoperational Task Times : Tasks 3, 4 and 5

	Time to Perform Task (sec)					
	BDU		MOPP		MOPP-L	
Iteration	1	2	1	2	1	2
Postoperation Task 3: Perform PM and after Firing Checks (Gunner)						
Platoon Crew No.						
First 1	190	325[b]	328[b]	220	323	231
Third 1	605	0[b]	0	123[a]	62	45
Fourth 1	57	0[b]	147	0[a]	90	62
Postoperation Task 4: Fill and Bleed Replenisher						
Platoon Crew No.						
First 2	0[b]	20[b]	95	54	25	20
Third 2	355	0[b]	455	36[a]	37	40
Fourth 2	20	0[b]	105	0[a]	70	32
Postoperation Task 5: Perform PM and After Ops. Checks and Service						
Platoon Crew No.						
First 2	0[b]	211[b]	310	392	246	380
First 4	253	0[b]	302	108	501	268
Third 2	523	0[b]	593	307	590	320
Third 4	264	0[b]	233	400[a]	205	276
Fourth 2	190	0[b]	430	0[a]	32	307
Fourth 4	226	0[b]	182	0[a]	245	176

a. Second iteration was not performed.

b. Data not recorded.

Table 9. Postoperational Task Times : Tasks 6, 7 and 8

		Time to Perform Task (sec)					
		BDU		MOPP		MOPP-L	
	Iteration	1	2	1	2	1	2
Postoperation Task 6: Perform PM and After Firing Checks (Loader)							
Platoon	Crew No.						
First	2	0[b]	100	220	220	20	346
	3	518	180	352	249	278	270
	4	201	172[b]	130	243	157	133
Third	2	455	0[b]	471	177	312	170
	3	224	0[b]	95	288	97	82
	4	102	0[b]	190	272[a]	134	169
Fourth	2	170	0[b]	250	0[a]	322	190
	3	121	0[b]	139	0[a]	162	94
	4	149	0[b]	148	0[a]	238	194
Postoperation Task 7: Perform Operator Maintenance on M73 COAX MG							
Platoon	Crew No.						
First	3	0[b]	262[b]	130	420	210	178
Third	3	390	0[b]	95	165[a]	171	60
Fourth	3	96	0[b]	1129	0[a]	97	35
Postoperation Task 8: Remove and Install a Track Pad							
Platoon	Crew No.						
First	3	302	176[b]	270	201	91	192
Third	3	283	0[b]	404	342[a]	208	100
Fourth	3	173	0[b]	363	0[a]	307	167

a. Second iteration was not performed.
b. Data not recorded.

TABLE 10. Platoon Travel Times (minutes)

		Travel From				Travel From	
		Ass. Point To RPL[a]	RPL To BPL[b]	BPL To PDP	Total	PDP To Range	Range To ADP
First Platoon							
Uniform Iteration							
BDU	1	9	7	14	30	10	12
	2	0[b]	14	11	25	8	7
MOPP	1*	7	41	4	52	12	12
	2	2	20	14	36	14	10
MOPP-L	1	5	14	10	29	9	8
	2	2	17	13	32	9	10
Third Platoon							
Uniform Iteration							
BDU	1[a]	5	19	1	25	9	9
	2	4	22	3	29	8	c
MOPP	1	7	26	23	59	10	c
	2	11	6	41	58	11	10
MOPP-L	1	7	9	40	56	9	9
	2	0[b]	23	16	39	9	8
Fourth Platoon							
Uniform Iteration							
BDU	1	8	16	7	31	10	11
	2	7	18	2	27	9	c
MOPP	1[a]	13	17	17	47	15	10
	2	d					
MOPP-L	1	17	8	19	44	10	4
	2	10	32	2	44	12	11

* Initial trial for platoon.
b. RED phase line not reported

*** Trial completed at range.
**** Second iteration not performed.

3. Target Engagement Data

The target engagement phase of the trial was performed on Range 129 at the Pendleton test site. Figure 2 is a schematic of the range and shows the approximate position of the targets. There were two target types; one which was permanently displayed and the other, which was erected after the reception of a radio signal transmitted by range personnel. The range consisted of two separate portions. The front half was composed of four targets, all radio-controlled. Targets 1 and 4 were approximately 500 m from the tank path and targets 2 and 3 were approximately 200 m. For most tests, the targets were not operating properly. When a radio-controlled target was inoperable, the target would be erected permanently and could be seen and fired upon from the start line. All targets in the back portion of the range were permanent and could be seen when the tank cleared the small mountain on the left side of the tank path. Targets 5 and 6 were approximately 300 m from the path and target 7, referred to as the long-range target was approximately 1 km from the road.

The data for all target engagements can be found in Appendix A. A summary of target engagement data is presented in Tables 11 through 13. In these tables, the target engagement is the ratio of the targets engaged to the total number presented and the firing accuracy is the ratio of the number of targets "killed" to the number of rounds fired. For these tests, because of range restrictions, the tank main gun could not be used. In its place, the firing was performed with a system known as the TELFARE. The TELFARE system consisted of a 50-cal machine gun mounted on the main gun tube and operated in the single-shot mode. While at the target range assembly area, the TELFARE system of each tank was boresighted. However, because of uncertainties of the TELFARE mounting and the movement of the gun when being fired, these accuracy data should be considered a "worst case" situation.

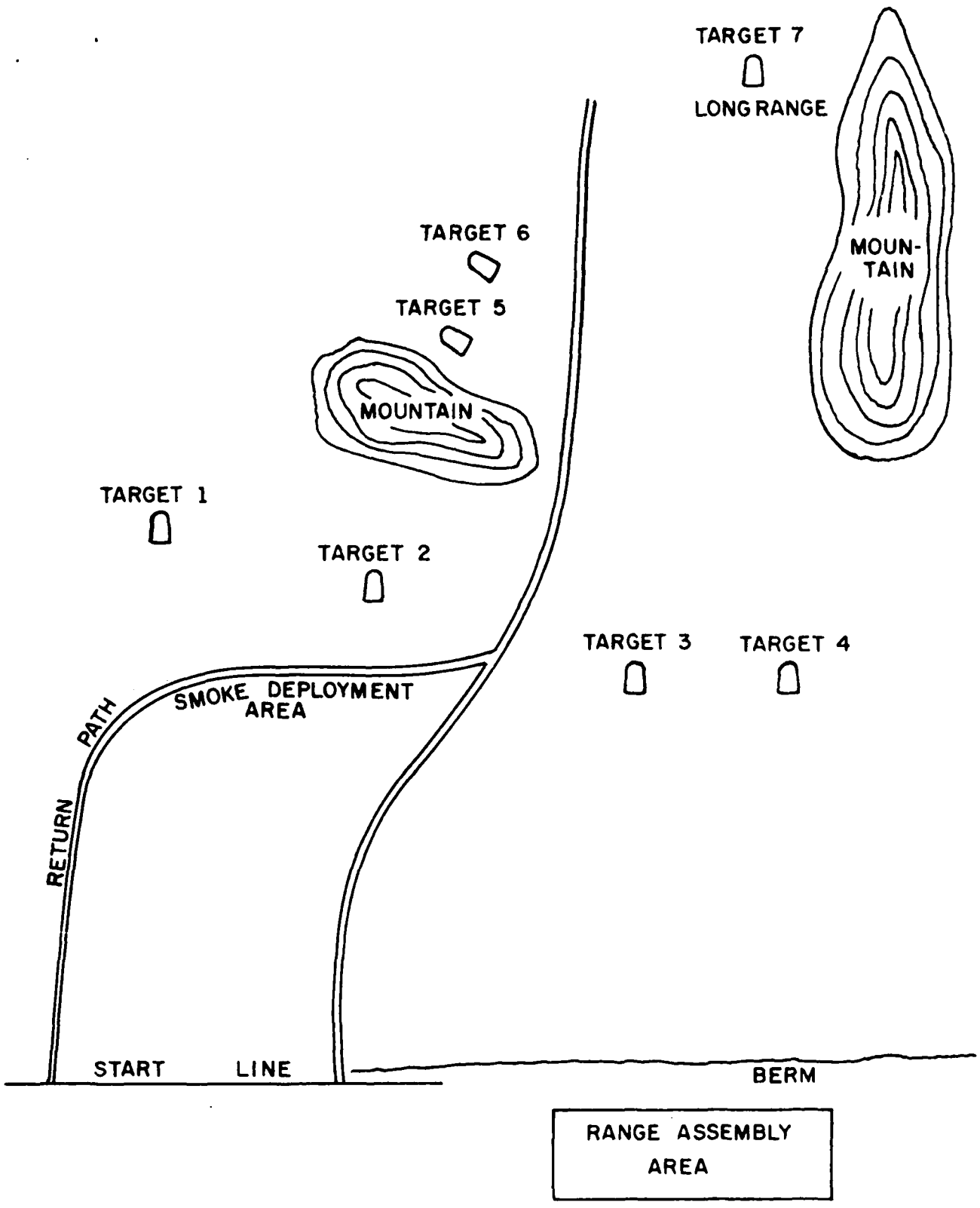

Figure 2. Target Engagement Range

TABLE 11. Target Engagement Summary Table: First Platoon

Uniform	Target Data			Rounds Fired	Target Engagment	Firing Accuracy
	Presented	Engaged	Killed			
Crew 1						
BDU	10	10	10	12	1.0	0.8
MOPP	8	8	7	15	1.0	0.5
MOPP-L	12	12	12	19	1.0	0.6
Crew 2						
BDU	10	10	10	14	1.0	0.7
MOPP	3	1	1	3	0.3	0.3
MOPP-L	12	11	11	19	0.9	0.6
Crew 3						
BDU	8	8	8	13	1.0	0.6
MOPP	7	7	7	10	1.0	0.7
MOPP-L	11	10	10	20	0.9	0.5
Crew 4						
BDU	10	10	9	14	1.0	0.6
MOPP	4	3	3	6	0.8	0.5
MOPP-L	12	12	12	15	1.0	0.8

TABLE 12. Target Engagement Summary Table : Third Platoon

Uniform	Target Data			Rounds Fired	Target Engagment	Firing Accuracy
	Presented	Engaged	Killed			
Crew 1						
BDU	7	7	7	10	1.0	0.7
MOPP	10	9	9	15	0.9	0.6
MOPP-L	9	9	9	10	1.0	0.9
Crew 2						
BDU	4	4	4	4	1.0	1.0
MOPP	10	9	9	10	0.9	0.9
MOPP-L	12	12	12	19	1.0	0.6
Crew 3						
BDU	7	7	7	13	1.0	0.5
MOPP	10	9	9	13	0.9	0.7
MOPP-L	12	12	12	14	1.0	0.9
Crew 4						
BDU	4	4	4	4	1.0	1.0
MOPP	10	8	8	12	0.8	0.7
MOPP-L	11	11	11	17	1.0	0.6

TABLE 13. Target Engagement Summary Table : Fourth Platoon

Uniform	Target Data			Rounds Fired	Target Engagment	Firing Accuracy
	Presented	Engaged	Killed			
Crew 1						
BDU	8	7	7	19	0.9	0.4
MOPP	6	6	6	10	1.0	0.6
MOPP-L	9	8	8	12	0.9	0.7
Crew 2						
BDU	11	11	11	19	1.0	0.6
MOPP	6	2	2	7	0.3	0.3
MOPP-L	11	11	11	15	1.0	0.7
Crew 3						
BDU	11	11	11	23	1.0	0.5
MOPP	6	2	2	5	0.3	0.4
MOPP-L	10	9	9	12	0.9	0.8
Crew 4						
BDU	8	8	8	16	1.0	0.5
MOPP	6	6	6	11	1.0	0.5
MOPP-L	10	10	10	14	1.0	0.7

4. Discussion

For several trials, the data for certain preoperation and postoperation tasks were not reported because the equipment or the personnel needed for the task were not present on the tank for that particular trial.

During these trials only three Marines "fell out" because of illness which occurred during the trial. The most noteworthy was the loss of a tank commander with a medical history of heat stress who fell out during the target engagement portion of the MOPP trial A2A-M. After treatment and removal of the sick person from the tank, the tank commander's position was assumed by the gunner and the trial completed. These data are included in the regression analysis.

During another trial, C3A-L, two Marines became ill. The first was a loader with a stomach ailment not related to the MOPP gear and the heat of the day. The second was a tank commander who collapsed during the reconnaissance of the PDP as a result of a faulty mask valve. After a short rest and a repair of the mask, the tank commander resumed his position in full MOPPIV attire.

IV. ANALYSIS AND DISCUSSION

This section presents the results of the regression analyses for individual tasks, platoon movements and the percentage of target engagement and firing accuracy. This regression analysis technique is explained in detail and an example provided in Appendix B. Malfunctions of the target handling equipment at the range made it impossible to have a constant target array presented to each tank crew for any given trial on the range. Since the regression analysis technique assumes similar tasks, this technique was not used to analyze the times to complete the target engagement and fire on the target.

1. Individual Tasks

a. **Analysis.** For these analyses, only those tasks which were properly performed were analyzed. This eliminated any task which create a safety hazard (e.g., ammunition handling) or required operation times which extended far beyond allotted test times (e.g. changing a track pad). These results can be found in Table 14. In this table, as in all the regression analyses tables, T_o is the unencumbered, practiced time, a is the correction for clothing (MOPPIV gear) and b is the time correction for

the unpracticed trial. The MOPPIV correction factor for any particular task is defined as the ratio $(T_o + a)/T_o$. Also shown in these tables is the probable range of the correction factor calculated by using the standard deviations of the clothing correction result.

TABLE 14. Individual Task Regression Analysis Results

Task	Unencumbered Time T_o (sec)	Clothing Correction a (sec)	Time Correction b (sec)	Correction Factor $(T_o + a)/T_o$
Prepare Driver Station	133	8 ± 39	77 ± 49	1.1 0.8-1.4*
Check Engine and Transmission Fluid Levels	216	48 ± 69	-11 ± 91	1.2 0.9-1.5*
Perform PM and After Ops. Checks and Service	262	39 ± 64	47 ± 64	1.2 0.9-1.4*

* Probable Range

b. **Discussion.** These data seem to indicate there is very little degradation effect created by clothing on the accomplishment of individual tasks. The maximum effect seems to be to the preoperation task of engine fluid checks. This may be caused by the increased trouble of handling and reading the oil level measuring stick.

2. **Platoon Movement**

a. **Analysis.** Only the total movement times to the PDP, range and AP were analyzed using the regression analysis. It was felt that these times provided the best data to measure movement degradation of the platoon. The results of this analysis can be found in Table 15.

TABLE 15. Platoon Movements Regression Analysis Results

Movement to	Unencumbered Time T_o (minutes)	Clothing Correction a (minutes)	Time Correction b (minutes)	Correction Factor $(T_o + a)/T_o$
PDP	27	17 ± 5	2 ± 6	1.6 1.4-1.8*
Range	9	2 ± 1	2 ± 1	1.2 1.1-1.3*
ADP	9	-1 ± 1	1 ± 2	1.0 0.9-1.1*

* Probable Range

b. **Discussion.** The time to travel to the PDP from the assembly area shows the most significant effect from the MOPPIV gear. This was the only segment of the travel which required that the crew remained "buttoned up" and this decrease in visibility might be sufficient to explain the increased travel time. During the test period, several comments were made by the drivers about how cumbersome the MOPP booties were and how they interfered with the operation of the driving pedals. However, it seems unreasonable to assume this to be the problem which causes the time increase because the same effect should have been seen when traveling to the range and the alternate defensive position.

3. **Target Engagement**

a. **Target Engagement and Firing Times.** A summary of the individual firing data found in Appendix A is presented in Table 16. As was stated in the previous section, during the target engagement portion of a trial at Range 129, there were two target types presented to each tank; one which was permanently displayed and the other, which was erected after the reception of a radio signal transmitted by range personnel. In this table, the permanently displayed and radio-controlled targets are referred to as permanent and pop-up, respectively. The table also refers to a long-range target which was the stationary target placed approximately 1.0 km from the tank path. The target engagement time is defined as that time required to detect a target, recognize it and begin adjustment of the tank main gun for target engagement. The time to fire at the first target is defined as that time from the beginning of the gun movement until the

discharge of the first round at the target. For some engagements two targets were presented simultaneously and the time to fire the first round at the second target is defined as the time between the "kill" of the first target and the firing of the first round at the second target. The times shown are the average of all like targets with the standard deviation for each summation. When a target was engaged at the range start line, the target engagement times, which would be zero, were not computed in the average. These data were used in the computation of the average time to fire the first round. Although the standard deviations for the data are large, they might be used to provide an overview of the effect of MOPP clothing.

TABLE 16. Target Engagement and Firing Times Summary

	Uniform	BDU		MOPP	
Time to	Target Type	Time (sec.)	Number of Targets	Time (sec.)	Number of Targets
Engage	Permanent	16 ± 13	20	30 ± 34	48
	Pop-up	13 ± 22	30	26 ± 30	43
	Long Range	70 ± 64	6	154 ± 117	20
Fire at	First Target	16 ± 15	63	14 ± 10	130
	Second Target	32 ± 33	35	39 ± 33	65

b. **Discussion.** The times to engage all three target types, permanent, pop-up and long range, are approximately a factor of two greater in the MOPP than in the BDU. Because these times include the detection and recognition of a target and the movement of the main gun in preparation for firing a round at the target, it seems reasonable to expect this degree of difference because of the manner in which the target detection was performed. While in BDU, the tank commander rode with the commander hatch open and had a view of the complete range. However, when the crew was in MOPP, the tank was "buttoned up" (all hatches closed) and the view of the range was restricted to the field-of-view of the M36E1, the commander sight of the M60A1 tank. The restriction alone could cause the factor of two increase in detection time.

The times to fire the first round at a target are essentially the same in BDU and MOPP. There is a slight difference, approximately 25%, for the fire time at the second target. This difference might again be caused by the fact that the crew is "buttoned up" and thus loses a certain amount of time acquiring the second target and laying the gun sights on target because of the restrictions of the field-of-view for both the M32E1 and the

M36E1, the gunner and commander daysight optics, respectively.

4. **Target Engagement and Firing Accuracy**

a. **Analysis.** The results for the regression analysis of the ratio of targets engaged to the total number presented and the firing accuracies are presented in Table 17. For these data T_o is the unencumbered, practiced ratio of target engagements and firing accuracies and a and b are the corrections for gear and unpracticed trial, respectively.

TABLE 17. Target Engagement and Accuracy Regression Analysis Results

Task to $(T_o + a)/T_o$	Unencumbered Percentage T_o	Clothing Correction a	Time Correction b	Correction Factor
Engagement	1.0	-0.1 ± 0.04	0.0 ± 0.03	1.0 1.0*
Accuracy	0.6	0.0 ±0.06	-0.1 ± .08	1.0 0.9-1.0*

* Probable Range

b. **Discussion.** These data show no effects from the clothing being worn by the personnel.

V. SUMMARY

The quantification of the degradation of a tank platoon with its' personnel performing in MOPPIV gear was determined for several individual tasks, platoon movements and target acquisition and firings. Events were proportionately weighted by the amount of time to completion and summed over all events to give an overall degradation. Table 18 presents the inverse of this degradation, the MOPPIV degradation correction factor, and the probable range of the factor. The time required to perform a task while wearing BDU multiplied by the MOPP degradation factor produces an estimate of the MOPPIV value for the analyzed tasks. The range for these factors can also be found in Table 18.

TABLE 18. Correction Factors for MOPP IV

Task	Correction	
	Factor	Range
Prepare Driver Station	1.1	0.8-1.4
Check Engine and Transmission Fluid Levels	1.2	0.9-1.5
Perform PM and After Ops. Checks and Service	1.2	0.9-1.4
Platoon Movements	1.6	1.4-1.8
Target Acquisition	1.0	1.0
Firing Accuracy	1.0	0.9-1.0

These field measurements of tank platoon operations have provided valuable and important data for the evaluation of troop performance in MOPPIV protective gear. The data generated by these trials have been categorized and will be compiled into a database with the other MOPP degradation trial results. This database can be used to improve estimates of performance degradation of similar tasks in MOPPIV and improve the inputs for operation research codes used to predict unit effectiveness and readiness.

APPENDIX A

Target Engagement Data

Target Engagement Data

During the target engagement portion of a trial at Range 129, there were two target types presented to each tank; one which was permanently displayed and the other, which was erected after the reception of a radio signal transmitted by range personnel. In these tables, the permanently displayed and radio-controlled targets are referred to as permanent and pop-up, respectively. In the tables there is also mentioned a long-range target. This was a permanent target placed approximately 1.0 km from the tank path.

The data for target engagements can be found in Tables A-1 through A-12. The Target Engagement time is defined as that time required to detect a target, recognize it and begin adjustment of the tank main gun for target engagement. The time to fire the first round, $\triangle$ t Fire 1, is defined as that time from the beginning of target engagement to the discharge of the first round at the target. For some engagements two targets were presented simultaneously and the time to fire the first round at the second target, $\triangle$ t Fire 2, is defined as the time between the kill of the first target and the firing of the first round at the second target.

The trial numbering system included plat n involved "A", "B" and "D" for the first, third and fourth platoon, respectively; the test number for the particular platoon, 1, 2 or 3, the iteration of the day, "A" for the morning and "P" for the evening; and finally, "B", "M" and "L" for the uniform type *BDU* and each platoon's first and second trial in MOPPIV, respectively.

TABLE A-1. Target Engagement Data

First Platoon : Crew 1										
			Engagement Data							
Trial Number	Dress	Init Trial	Targets Number	Type	Time (seconds) Target Engage	Δt Fire 1	Δt Fire 2	Number Hits	Rds
A1AR1-B	BDU	No	2	Permanent	0	12	43	2	3
			1	Pop-up	19	11		1	1
			1	Pop-up	19	30		1	2
A1PR1-B	BDU	No	2	Permanent	45	10	20	2	2
			1	Pop-up	2	8		1	1
			1	Pop-up	3	9		1	1
			2	Permanent	3	10	22	2	2
A2A-M	MOPP	Yes	2	Permanent	0	11	39	2	6
			1	Pop-up	4	11		1	1
			1	Pop-up	27	13		0	2
			1	Long Range	136	14		1	2
A2P-M	MOPP	No	1	Permanent	0	15		1	2
			1	Pop-up	10	10		1	1
			1	Permanent	0	15		1	1
A3A-L	MOPP	No	2	Permanent	10	10	80	2	5
			1	Pop-up	4	6		1	1
			2	Permanent	20	10	15	2	2
			1	Long Range	120	20		1	2
A3P-L	MOPP	No	2	Permanent	40	10	105	2	4
			1	Pop-up	5	2		1	1
			2	Permanent	90	6	13	2	3
			1	Long Range	165	20		1	1

TABLE A-2. Target Engagement Data

First Platoon : Crew 2									
			Engagement Data						
Trial Number	Dress	Init Trial	Targets Number	Type	Time (seconds) Target Engage	Δt Fire 1	Δt Fire 2	Number Hits	Rds
A1AR1-B	BDU	No	2	Permanent	0	8	15	2	3
			1	Pop-up	8	11		1	1
			1	Pop-up	3	9		1	4
A1PR1-B	BDU	No	2	Permanent	0	12	25	2	2
			1	Pop-up	10	20		1	1
			1	Pop-up	4	11		1	1
			2	Permanent	8	22	5	2	2
A2A-M	MOPP	Yes	1	Permanent	140	7		1	3
A2A-L	MOPP	No	2	Permanent	70	20	45	2	4
			2	Permanent	10	15	30	2	3
			1	Long Range	260	15		1	1
A2P-L	MOPP	No	2	Permanent	15	20	130	2	5
			1	Pop-up	40	14		1	1
			2	Permanent	15	15	25	2	3
			1	Long Range	240	25		1	2

TABLE A-3. Target Engagement Data

First Platoon : Crew 3									
			Engagement Data						
Trial Number	Dress	Init Trial	Targets Number	Type	Time (seconds) Target Engage	Δt Fire 1	Δt Fire 2	Number Hits	Rds
A1AR1-B	BDU	No	2	Permanent	0	10	30	2	5
			1	Pop-up	10	27		1	1
			1	Pop-up	20	8		1	1
A1PR1-B	BDU	No	1	Permanent	0	15		1	3
			1	Pop-up	4	5		1	1
			2	Permanent	10	6	21	2	2
A2A-M	MOPP	Yes	1	Permanent	132	5		1	1
			1	Pop-up	30	20		1	2
			1	Pop-up	32	21	12	2	2
A2P-M	MOPP	No	1	Permanent	0	12		1	3
			2	Pop-up	5	11	11	2	2
A3A-L	MOPP	No	2	Permanent	25	10	60	2	5
			1	Pop-up	5	10		1	2
			2	Permanent	27	10	20	2	3
A3P-L	MOPP	No	2	Permanent	10	10	10	2	3
			2	Permanent	5	10	30	2	4
			1	Long Range	25	15		1	3

TABLE A-4. Target Engagement Data

First Platoon : Crew 4									
			Engagement Data						
Trial Number	Dress	Init Trial	Targets Number	Type	Time (seconds) Target Engage	Δt Fire 1	Δt Fire 2	Number Hits	Rds
A1AR1-B	BDU	No	2	Permanent	0	12	18	2	3
			1	Pop-up	4	4		1	1
			1	Pop-up	5	9		0	1
A1PR1-B	BDU	No	2	Permanent	0	10	10	2	2
			1	Pop-up	5	5		1	1
			1	Pop-up	60	15		1	2
			2	Permanent	10	8	12	2	4
A2A-M	MOPP	Yes	1	Permanent	4	6		1	4
			1	Permanent	0	7		1	1
			1	Pop-up	5	5		1	1
A3A-L	MOPP	No	2	Permanent	25	20	30	2	2
			1	Pop-up	9	5		1	1
			2	Permanent	10	1[illegible]	50	2	2
			1	Long Range	320	10		1	2
A3P-L	MOPP	No	2	Permanent	10	25	115	2	3
			1	Pop-up	3	24		1	1
			2	Permanent	10	5	15	2	2
			1	Permanent	10	30		1	2

TABLE A-5. Target Engagement Data

Third Platoon : Crew 1									
			Engagement Data						
Trial Number	Dress	Init Trial	Targets Number	Type	Time (seconds) Target Engage	Δt Fire 1	Δt Fire 2	Number Hits	Rds
C1A-B	BDU	Yes	2	Pop-up	4	18	17	2	4
			2	Permanent	3	24	8	2	2
C1P-B	BDU	No	2	Pop-up	4	20	41	2	3
			1	Pop-up	4	81		1	1
C2A-M	MOPP	No	2	Permanent	75	10	100	2	4
			1	Pop-up	70	10		1	1
			2	Permanent	15	10	20	2	3
			1	Long Range	90	10		1	2
C2P-M	MOPP	No	2	Permanent	25	15	60	2	4
			1	Pop-up	55	10		1	1
C3A-L	MOPP	No	2	Permanent	40	16	39	2	2
			1	Pop-up	12	25		1	1
C3P-L	MOPP	No	2	Permanent	5	50	85	2	2
			1	Pop-up	20	10		1	1
			2	Permanent	10	10	15	2	2
			1	Long Range	120	20		1	2

TABLE A-6. Target Engagement Data

Third Platoon : Crew 2									
			Engagement Data						
Trial Number	Dress	Init Trial	Targets Number	Type	Time (seconds) Target Engage	Δt Fire 1	Δt Fire 2	Number Hits	Rds
C1A-B	BDU	Yes	2	Pop-up	6	10	19	2	2
			2	Pop-up	5	11	9	2	2
C2A-M	MOPP	No	2	Permanent	4	22	54	2	3
			1	Pop-up	5	7		1	1
			2	Permanent	10	12	20	2	2
C2P-M	MOPP	No	2	Permanent	25	8	42	2	2
			1	Pop-up	12	5		1	1
			1	Pop-up	25	5		1	1
C3A-L	MOPP	No	2	Permanent	20	22	45	2	3
			1	Pop-up	42	5		1	2
			2	Permanent	13	14	13	2	2
			1	Long Range	10	12		1	4
C3P-L	MOPP	No	2	Permanent	17	8	35	2	2
			1	Pop-up	30	6		1	1
			2	Permanent	15	31	10	2	3
			1	Long Range	160	80		1	2

TABLE A-7. Target Engagement Data

Third Platoon : Crew 3									
			Engagement Data						
Trial Number	Dress	Init Trial	Targets Number	Type	Time (seconds) Target Engage	Δt Fire 1	Δt Fire 2	Number Hits	Rds
C1A-B	BDU	Yes	2	Pop-up	4	8	10	2	2
			2	Pop-up	13	12	15	2	4
C1P-B	BDU	No	2	Pop-up	6	8	30	2	5
			1	Pop-up	5	14		1	2
C2A-M	MOPP	No	2	Permanent	17	15	25	2	4
			1	Pop-up	25	22		1	1
			2	Permanent	15	10	10	2	2
			1	Long Range	150	12		1	2
C2P-M	MOPP	No	2	Permanent	17	13	60	2	3
			1	Pop-up	4	8		1	1
C3A-L	MOPP	No	2	Permanent	7	13	27	2	2
			1	Pop-up	7	8		1	2
			2	Permanent	9	16	10	2	2
			1	Long Range	5	4		1	1
C3P-L	MOPP	No	2	Permanent	12	33	45	2	3
			1	Pop-up	4	6		1	1
			2	Permanent	15	5	25	2	2
			1	Long Range	315	25		1	1

TABLE A-8. Target Engagement Data

Third Platoon : Crew 4									
			Engagement Data						
Trial Number	Dress	Init Trial	Targets Number	Type	Time (seconds) Target Engage	Δt Fire 1	Δt Fire 2	Number Hits	Rds
C1A-B	BDU	Yes	2	Pop-up	30	17	13	2	2
			2	Pop-up	4	21	0	2	2
C2A-M	MOPP	No	2	Permanent	20	20	32	2	4
			1	Pop-up	4	14		1	1
			2	Permanent	25	15	15	2	2
C2P-M	MOPP	No	2	Permanent	0	30	35	2	4
			1	Pop-up	110	5		1	1
C3A-L	MOPP	No	2	Permanent	0	6	14	2	3
			1	Pop-up	5	5		1	1
			2	Permanent	7	10	18	2	3
			1	Long Range	10	10		1	3
C3P-L	MOPP	No	2	Permanent	35	5	27	2	3
			2	Permanent	15	2	9	2	3
			1	Long Range	15	10		1	1

TABLE A-9. Target Engagement Data

Fourth Platoon : Crew 1										
			Engagement Data							
Trial Number	Dress	Init Trial	Targets Number	Type	Time (seconds) Target Engage	Δt Fire 1	Δt Fire 2	Number Hits	Rds
B3A-B	BDU	No	2	Permanent	40	15	55	2	5
			1	Pop-up	5	15		1	1
			2	Permanent	15	25	155	2	3
			1	Permanent	7	68		1	5
			1	Long Range	165	10		1	5
B1A-M	MOPP	Yes	2	Pop-up	20	20	65	2	3
			2	Pop-up	40	20	10	2	2
			2	Pop-up	30	20	20	2	5
B2A-L	MOPP	No	2	Permanent	37	13	35	2	5
			1	Pop-up	15	10		1	1
			2	Permanent	90	11	144	2	3
B2P-L	MOPP	No	2	Permanent	30	22	13	2	2
			1	Long Range	380	10		1	1

TABLE A-10. Target Engagement Data

Fourth Platoon : Crew 2										
			Engagement Data							
Trial Number	Dress	Init Trial	Targets Number	Type	Time (seconds) Target Engage	Δt Fire 1	Δt Fire 2	Number Hits	Rds
B3A-B	BDU	No	2	Permanent	15	10	122	2	4
			1	Pop-up	110	20		1	1
			2	Permanent	6	14	20	2	4
			1	Long Range	65	10		1	3
B3P-B	BDU	No	2	Permanent	12	13	85	2	2
			2	Permanent	45	10	10	2	3
			1	Long Range	130	10		1	2
B1A-M	MOPP	Yes	1	Permanent	0	0		1	5
			1	Pop-up	140	10		1	2
B2A-L	MOPP	No	2	Permanent	17	23	35	2	4
			2	Pop-up	20	20	47	2	2
			2	Permanent	25	15	67	2	3
B2P-L	MOPP	No	1	Pop-up	45	8		1	1
			1	Pop-up	60	7		1	1
			2	Permanent	12	16	17	2	2
			1	Long Range	280	7		1	2

TABLE A-11. Target Engagement Data

Fourth Platoon : Crew 3									
			Engagement Data						
Trial Number	Dress	Init Trial	Targets Number	Type	Time (seconds) Target Engage	Δt Fire 1	Δt Fire 2	Number Hits	Rds
B3A-B	BDU	No	2	Permanent	15	15	29	2	3
			1	Pop-up	4	10		1	1
			2	Permanent	20	10	15	2	2
			1	Long Range	9	8		1	4
B3P-B	BDU	No	2	Permanent	7	14	44	2	5
			2	Permanent	15	15	15	2	2
			1	Long Range	20	85		1	6
B1A-M	MOPP	Yes	1	Pop-up	5	-5		1	1
			1	Pop-up	11	24		1	4
B2A-L	MOPP	No	2	Permanent	0	0	10	2	3
			2	Pop-up	4	6	37	2	2
B2P-L	MOPP	No	2	Permanent	6	15	149	2	4
			1	Pop-up	65	2		1	1
			1	Permanent	45	15		1	1
			1	Long Range	220	10		1	1

TABLE A-12. Target Engagement Data

Fourth Platoon : Crew 4										
			Engagement Data							
Trial Number	Dress	Init Trial	Targets Number	Type	Time (seconds) Target Engage	Δt Fire 1	Δt Fire 2	Number Hits	Rds
B3A-B	BDU	No	2	Permanent	12	13	50	2	6
			1	Pop-up	7	9		1	1
B3P-B	BDU	No	2	Permanent	13	14	83	2	4
			2	Permanent	10	12	8	2	2
			1	Long Range	30	10		1	3
B1A-M	MOPP	Yes	2	Permanent	0	10	20	2	3
			1	Pop-up	7035	-63		1	4
			1	Pop-up	34	6		1	2
			2	Pop-up	6	24	27	2	2
B2A-L	MOPP	No	2	Permanent	13	24	40	2	2
			2	Pop-up	4	11	30	2	2
B2P-L	MOPP	No	2	Permanent	15	1[illegible]	33	2	4
			1	Pop-up	3	4		1	1
			2	Permanent	15	10	25	2	2
			1	Long Range	60	5		1	3

APPENDIX B

Multiple Linear Regression

Multiple Linear Regression

Regression analyses are used to quantify the relationship between variables where the value of one is affected by changes in others. The type of uniform worn and whether or not the event was completed for the first time, either in BDU or MOPPIV, are independent variables. A multiple linear regression allows a dependent variable to be estimated by quantifying the relationship to several independent variables. In this instance, time to complete a task is the affected or dependent variable. Interactions and variables not measured are reflected in the error term and include such effects as team work and leadership. An estimate of how well the regression estimates the dependent variable is expressed by the multiple correlation coefficient. Analysis then can be used to determine the effect of MOPPIV and the first time effect on the total time to complete a task.

For troop performance studies the regression expression is represented by:

$$T = T_o + a(x) + b(y) + e \qquad \text{(B-1)}$$

Where "T" (the dependent variable) is the total time in minutes to complete a task, "T_o" (the intercept) is the practiced, unencumbered time, "x" (first independent variable) is the clothing type, "y" (second independent variable) is the order in which an event was started and "e" is the error term. Because it is assumed that the clothing contribution would be zero for wearing BDUs "x" is represented by either a "0" or a "1." Likewise, if a team was working an event for the first time "y" would be assigned a "1" and if the team had completed the event before. A "0" would be assigned since no first time effect would be present. The expression, without the error term, then becomes:

$$T = T_o + a + b \qquad \text{(B-2)}$$

Where "a" and "b" represent the correction in minutes for MOPPIV and practiced factors, respectively. Therefore, a team completing an event for the first time in BDU is expressed as:

$$T = T_o + b \qquad \text{(B-3)}$$

A team performing an event in BDU two or more times would be represented as "T_o," ($T = T_o$). By wearing MOPPIV this team would add a clothing correction for MOPPIV and be expressed as:

$$T = T_o + a \qquad \text{(B-4)}$$

The event time for the same team completing the event for the first time and wearing MOPPIV would be expressed as:

$$T = T_o + a + b \qquad \text{(B-5)}$$

An example case will be replacing the shroud during the removing/replacing of the M60A3 transmission, accomplished during the Maintenance Evaluation completed under moderate temperature. All other tasks and events were likewise evaluated and are included in the results.

Replacing the shroud includes the placement of the shroud on the powerpack and the connection of the attachment bolts. The data for evaluation is given in Table B-1, where team 1 replaced the shroud twice, with the first occurrence in BDU in 7.8 minutes and the second occurrence in MOPPIV in 14.2 minutes. For this example, the resulting regression coefficients in Table B-2, are "T_o", the practiced, unencumbered time, "a", the additional time for MOPPIV, plus or minus the standard deviation and "b", the additional time needed if the event is done for the first time, plus or minus the standard deviation. Thus, the expected time for replacing the shroud is 5.8 minutes for a practiced unencumbered team. An additional 3.8 minutes is added to the total if the team was wearing MOPPIV, for an expected time of 9.6 minutes. This additional MOPPIV time could be as much as 11.5 minutes (9.6+1.9) or as little as 7.7 minutes (9.6-1.9). No correction is required for the first time effect because, in this example, the coefficient is negative (Table B-2). In other events this first time correction is calculated the same as for the MOPPIV effect.

TABLE B-1. Data Used in Example Regression

Team	BDU	MOPPIV	1st Time
1	7.8	14.2	BDU
2	4.6	24.6*	MOPP
3	5.8	10.2	BDU
4	6.4	7.4	MOPP**
5	3.6	6.3	MOPP

* Data excluded due to the removal of items not associated with trial.
** Team is practiced in both uniforms.

TABLE B-2. Regression Coefficients for Example

Coefficients
T_o = 5.8
a = 3.8±1.9
b = -0.5±2.0

The quotient resulting from "$T_o/(T_o + a)$" represents the degradation for wearing MOPPIV. That is, the unencumbered practiced time "T_o" divided by the total time for MOPPIV "$T_o + a$." Thus a team replacing the shroud in MOPPIV is degraded to 60 percent of their practiced, unencumbered ability, 5.8/(5.8+3.8)=0.60 (Table B-3). In a similar calculation, the degradation for doing the job for the first time results from the quotient of "$T_o/(T_o+b)$." In this example no degradation was determined for doing the event for the first time. A team is degraded to 0.63 if replacing the shroud for the first time and in MOPPIV, where both MOPPIV and first time coefficients are added in the denominator, i.e., "T_o/T_o+a+b." The quantity "$(T_o+a)/T_o$" (which is the inverse of the degradation factor) is called the MOPPIV Correction Factor. This factor when multiplied by "T_o" gives the expected time to complete a task in MOPPIV. For this example the correction factor is 1.66. A probable range is determined by making the correction factor calculation using plus or minus the standard deviation, given for each coefficient. The estimated time for this event is then 5.8x1.66 or 9.6 minutes. The results give a real number estimate of the effect of MOPPIV on this job performance (Table B-4).

TABLE B-3. Calculations for Example

Calculations
T_o = 5.8
T_o +a = 9.6
T_o +b = 5.3
T_o +a+b = 9.1
$T_o/(T_o$ +a) = 0.60
$(T_o+a)/T_o$ = 1.66
$T_o/(T_o$ +b) = 1.09
a/T_o = 0.66

TABLE B-4. Example Results

Effect of Wearing MOPPIV on Replacing the Shroud	
Degraded Effectiveness	0.60
MOPPIV Correction Factor	1.7
Probable Range	1.3-2.0

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